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(पहला पुनरीक्षण)

Geosynthetics — Guidelines for Installation of Geotextile used in Subgrade Separation in Pavement Structures

(First Revision)

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Geosynthetics Sectional Committee, TXD 30

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Geosynthetics Sectional Committee had been approved by the Textile Division Council.

This standard was first published in the year 2015 and has now been revised to incorporate the modified requirement of overlap.

A large variety of detrimental factors, such as environmental conditions, subgrade conditions, traffic loading, utility cuts, road widening, ageing, etc, contribute to distress in pavements which need to be addressed in the maintenance or rehabilitation of the pavements. Pavement maintenance treatments are often ineffective and short lived due to their inability to both, treat the cause of the problem and renew the existing pavement condition. The main cause of distress in pavements is the inability of pavement materials to drain out precipitated surface water infiltrating through the pavement, leading to softening and weakening of pavement subgrade and base thus accelerating pavement degradation. Further, existing pavement distress such as surface cracks, rocking joints and subgrade failures cause the rapid reflection of cracking up through the maintenance treatment.

The preferred strategy for long-term road and pavement performance should, therefore, be to build in safeguards during initial construction. These performance safeguards include stabilizing the subgrade against moisture intrusion and associated weakening, strengthening road based aggregate with efficient drainage of infiltrated water, and as a last resort, enhancing the stress absorption and moisture proofing capabilities of selected maintenance treatments.

The geogrids and the geotextiles are the most cost effective tools for safeguarding roads and pavements. Geosynthetics extend the service life of roads, increase their load-carrying capacity, and reduce rutting. The most common method for quantifying the geosynthetic benefits is the determination of Traffic Benefit Ratio (TBR) which is defined as the ratio of reinforced load cycles to failure (excessive rutting) to the number of cycles that cause failure of an unreinforced road section. In general, geosynthetics have been found to provide a TBR in the range of 1.5 to 70, depending on the type of geosynthetic, its location in the road, and the testing scenario. The researchers have found that for weak subgrades (CBR = 2 percent) the geotextile extends the service life of a flexible pavement section by a factor of 2.5 to 3.0 compared to a non-stabilized section. Further, a geotextile effectively increased the pavement section's total AASHTO structural number by approximately 19 percent. Similarly, for pavement sections with moderate strengths (CBR = 4.2 to 4.5 percent), the geotextile increased the service life of the pavement section by a factor of 2.0 to 3.3 and the AASHTO structural number increased by 13 to 22 percent. Also, the benefit of inclusion of geosynthetic material is briefed with design methodologies in IRC SP 59 : 2019 'Guidelines for use of geosynthetics in road pavements and associated works (*first revision*)'. Both geotextiles and geogrids thus can play an important role in extending the life of a roadway system.

The four main applications of geosynthetics in roads are subgrade separation, subgrade stabilization, base/ subbase reinforcement and overlay stress absorption and sub-surface drainage. Subgrade stabilization and base reinforcement involve improving the road structure as it is constructed by inserting an appropriate geosynthetic layer. Base reinforcement is the use of geosynthetics to improve the structure of a paved road.

Subgrade separation and stabilization applies geosynthetics to both unpaved and paved roads. When serving as a separator, the geotextile prevents fines from migrating into the base course and/or prevents base course aggregate from penetrating into the subgrade. The soil retaining properties of the geotextile are basically the same as those required for drainage and filtration. Therefore, the retention and permeability criteria required for drainage should be met. In addition, the geotextile should withstand the stresses resulting from the load applied to the pavement. The nature of these stresses depend on the condition of the subgrade, type of construction equipment and the cover over the subgrade. Since the geotextile serves to prevent aggregate from penetrating the subgrade, it shall meet puncture, burst, grab and tear strengths required. At small rut depth, the strain in the geosynthetic is also small. In this case, the geosynthetic acts primarily as a separator between the soft subgrade and the aggregate. Any geosynthetic that survives construction will work as a separator. This application is limited to soils which either in initially or seasonably have a CBR > 3 but < 8. In this application the geotextile is a substitute for the choked subbase stone commonly used over plastic subgrades. It is important to understand that this function may be required when geogrids are used to provide base reinforcement or confinement.

For larger rut depths, more strain is induced in the geosynthetic where the stiffness properties of geosynthetic are essential. A considerable reduction in aggregate thickness is possible by the use of geosynthetic having a high modulus in the direction perpendicular to the road centerline; however, the benefits of the geosynthetics are dependent on the membrane action achieved with a stiff geosynthetic as well as the lateral movement. For very weak subgrades, it is often beneficial to combine the benefits of both separation and stabilization. The following general conclusion can be drawn relating to a typical road base:

a) A geosynthetic element that functions primarily as a separator (typically when the subgrade CBR > 3) will prevent the mixing of poor soils with granular materials of pavement (*separation geotextiles*). This will enhance the long term performance of pavement.

b) A geosynthetic element that functions primarily to provide confinement of the aggregate and lateral restraint to the subgrade (typically when the subgrade CBR < 3) will both increase the allowable bearing capacity of the subgrade and provide an improved load distribution ratio in the aggregate. The combined benefits can enhance load carrying capacity of the road by well over 50 percent (*stabilization geogrids, geocells and geotextiles*).

The general rules for use of geogrids and geotextiles in roadway system are as follows:

a) *Temporary Roads* — Used for hauling and access roads that are subject to low volume of traffic including working platform for permanent road construction:

    1) *Clayey or silty subgrade with California Bearing Ratio (CBR) < 4* — If a clean base aggregate is used, then a non-woven separator geotextile shall be used. If a "choked aggregate" like general crusher run is used, then use either a geotextile or a biaxial geogrid that has good aperture stability and appropriate size. For a design equivalent single axle loading (ESAL) less than 1 000, a woven geotextile designed for both separation and membrane roles may be used, that is, consider the geotextile's modulus. For larger ESAL, use a woven or non-woven geotextile designed simply for separation. The reinforcement role of the geogrid seems safe for approximately 10 000 ESAL.

    2) *Sandy subgrade with CBR < 3* — Select a biaxial geogrid with good aperture stability and appropriate size or, a woven geotextile that has a reasonable interface friction with the sand and the aggregate. If a woven geotextile is considered, care should be taken to ensure that it does not actually create a slick slip-plane beneath the aggregate, that is, look at the interface friction by using geotextiles with high surface roughness which leads to enhanced interface friction.

b) *Permanent Roads (ESAL > 200 000):*

    1) *Clayey or silty subgrade with CBR < 3* — Consider building a working platform using the temporary road methods upon which conventional road can be constructed.

    2) *Clayey or silty subgrade with 3 < CBR < 8* — If there is any potential for degradation due to water intrusion, frost heave, etc. then include a separator geotextile to protect the base aggregate during these periods.

    3) *Sandy subgrades with CBR < 3* — Use a biaxial geogrid that has good aperture stability and appropriate size to reinforce the base aggregate. This is particularly helpful when poor quality stone and small aggregate thickness is used, less than 25 cm.

Geosynthetics can also be used as inter layers by placing them below or within the overlay (asphalt concrete) and are thus helpful in rehabilitating distressed road surfaces. These may also provide a moisture barrier.

Survivability is very important from the viewpoint of its long-term durability and is defined as resistance to mechanical damage during road construction and initial operation. The ability of a geosynthetic to survive installation and reasonable service loads shall be assured if it is to perform as designed. Installation damage to a geotextile is a function of the following:

a) Geotextile thickness,

b) Compactive effort and lift thickness,

c) Type and weight of construction equipment used for fill spreading,

d) Grain size distribution of backfill,

e) Angularity of backfill,

f) Polymer used in the manufacture of geotextile, and

g) Geotextile manufacturing process.

Geotexiles are mainly made from polyester (PET) or polypropylene (PP). PP is lighter than water, strong and very durable. PET is heavier than water, has excellent strength and creep properties, and is compatible with most common soil environments. Geotextiles are mainly of two types, namely, woven and non-woven geotextiles. Knitted and stitch bonded geotextiles are occasionally used in the manufacture of specialty products. Non-woven geotextiles are highly desirable for subsurface in planer drainage, and erosion control applications as well as, for road stabilization over wet moisture sensitive soils. Out of woven geotextiles, slit film fabrics geotextiles are commonly used for sediment control, that is silt fence and road stabilization applications but are poor choices for subsurface drainage and erosion control applications. Monofilament woven geotextiles have better permeability making them suitable for certain drainage and erosion control applications. High strength multifilament woven geotextiles are primarily used in reinforcement applications.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

GEOSYNTHETICS — GUIDELINES FOR INSTALLATION OF GEOTEXTILE USED IN SUBGRADE SEPARATION IN PAVEMENT STRUCTURES

(First Revision)

1 SCOPE

This standard prescribes guidelines for installation of geotextile used in subgrade separation in pavement structures.

2 SURFACE PREPARATION

The graded surface shall be smooth and free of obstructions, depressions and debris. Clear and grade the installation area. Remove all sharp objects and large stones. Cut trees and shrubs flush with the subgrade. Removal of topsoil and vegetation mat is not necessary, but is recommended where practical. Excessive soft spots or voids may be unsuitable for geosynthetic installation.

3 DEPLOYMENT OF THE GEOSYNTHETIC

3.1 Unroll the geosynthetic in the direction of construction traffic. Hold the geosynthetic in place with pins, staples, fill materials or rocks. Do not drag the geotextile on the ground or mishandle in any way. Loosely place the geotextile without wrinkles or folds, and with no void spaces between the geotextile and the ground surface so that the placement of the overlying material not tear the geotextile. Lap or sew the geotextile at the ends and sides of adjoining sheets as specified by the construction drawings or by the Engineer. Successive sheets of geotextiles shall be overlapped a minimum of 300 mm, with the upstream sheet overlapping the downstream sheet.

3.2 In case of slopes, place the geotextile with the machine direction oriented up-down. Lap the upper sheets over the lower sheets. When the geotextile is placed on a slope steeper than 6V:1H, securely anchor the laps to the ground surface with pins or stakes as necessary to prevent the slippage and tearing of the geotextile. Start placement of fill material on the geotextile at the toe of the slope and proceed upwards.

3.3 On curves, the geosynthetic may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, or piles of fill or rock.

3.4 If geotextiles are placed under water or in areas where water will flow, the geotextile may be placed with the machine direction parallel to the direction of water flow. Overlap sheets such that upstream sheet is placed over the top of the downstream sheet. Adequately secure the geotextile to prevent slippage. As the geotextile is placed under water, place the backfill material on it to the required thickness. Do not place geotextile more than 15 m ahead of the specified cover material.

3.5 The geosynthetic shall be laid smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic. Adjacent geosynthetic rolls shall be overlapped in the direction of construction. Depending on the strength of the subgrade, the overlaps may have to be sewn or joined as required in the plans Overlap shall be in the direction as shown on the plans or as given below:

Existing Subgrade Soil Strength (CBR)	*Minimum Overlap*
Greater than 3	300 – 450 mm
1 - 3	0.6 – 1 m
0.5 - 1	1 m or sewn
Less than 0.5	Sewn
All roll ends	1 m or sewn

3.6 The base reinforcement geosynthetic shall be laid as per the design requirements.

3.7 When field sewn seams are required, sew field seams with polymeric thread consisting of polypropylene or polyester and as resistant to deterioration as the geotextile being sewn. Use a colour of thread that contrasts with the geotextile being sewn so that the stitches are exposed for inspection when the geotextile is placed. Seams shall meet the testing requirements given below:

a) Use two rows of lock type stitching, to make the seams. The two rows of stitching shall be 12 mm apart with a tolerance of ± 6 mm and not cross except for restitching.

b) The minimum seam allowance (the minimum distance from the edge of geotextile to the nearest stitching shall be:

Flat or prayer seam, Type SSa-1	40 mm
"J" Seam, Type SSn-1	25 mm
Butterfly-folded seam, Type SSd-1	25 mm

c) Obtain the geotextile manufacturer's recommendation for the type of seam and stitch to be used. If the contractor does not obtain and provide this information, use a "J" seam with at least three stitches per 25 mm. The flat or prayer seam may be used for repair or damaged in-place geotextile.

3.8 Prior to covering, the geosynthetic shall be inspected by a certified inspector of the engineer to ensure that the geosynthetic has not been damaged during installation. Damaged geosynthetic shall be repaired or replaced immediately. In case the geotextile is damaged during installation, or aggregate placement, a geotextile patch shall be placed over the damaged area extending beyond the damaged area a distance of 300 mm, or the specified seam overlap, whichever is greater.

3.9 The geotextile shall be laid at the proper elevation and alignment as shown on the construction drawings. The geotextile may be temporarily secured in place with ties, staples, pins, sand bags or backfill as required by fill properties, fill placement procedures or weather conditions.

3.10 Placement of drainage aggregate shall proceed immediately following placement of the geotextile. The geotextile shall be covered with a minimum of 150 mm of loosely placed aggregate prior to compaction. The aggregate shall be compacted with vibratory equipment unless the trench is required for structural support. The subbase or base shall be placed by end dumping onto the geosynthetic from the edge of the geosynthetic, or over previously placed subbase or base aggregate. On soils with CBR > 3, most rubber-tired vehicles can be driven at slow speeds, less than 16 km/h and in straight paths over the exposed geosynthetic without causing damage to the geosynthetic. Sudden braking and sharp turning should be avoided. Tracked construction equipment should not be operated directly upon the geosynthetic. A minimum fill soil thickness of 15 cm is required prior to operation of tracked vehicles over the geosynthetic. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geosynthetic. Do not use rubber-tired equipment directly on the geotextile when woven, multilayer, or welded strip geotextile are used.

3.11 For soils with CBR < 1, construction vehicles shall not be allowed directly on the geosynthetic. The sub-base or base shall be placed such that at least the minimum specified lift thickness shall be between the geosynthetic and equipment tires or tracks at all times. Turning of vehicles shall not be permitted on the first lift above the geosynthetic.

3.12 On subgrades having a CBR value of less than 1, the sub-base or base aggregate should be spread in its full thickness as soon as possible after dumping to minimize the potential of localized subgrade failure due to overloading of the subgrade.

3.13 Any ruts occurring during construction shall be filled with additional subbase or base material, and compacted to the specified density.

3.14 If placement of the backfill material causes damage to the geosynthetic, the damaged area shall be repaired as previously described above. The placement procedure shall then be modified to eliminate further damage from taking place.

3.15 The geotextile shall be laid at the proper elevation and alignment as shown on the construction drawings. The geotextile shall be installed in accordance with the installation guidelines provided by the manufacturer or as directed by the Engineer. The geotextile may be temporarily secured in place with ties, staples, pins, sand bags or backfill as required by fill properties, fill placement procedures or weather conditions or as directed by the Engineer.

3.16 Place, spread, and compact granular fill material in such a manner that minimizes the development of wrinkles in or movement of the geotextile.

4 PROTECTION OF GEOTEXTILE

4.1 Protect the geotextile at all times from ultraviolet (UV) rays, contamination by surface runoff and construction activities. Traffic or construction equipment shall not be permitted directly on the geotextile except as directed.

4.2 During installation, cover the geotextile with specified cover material as soon as possible. Do not leave in uncovered condition for more than five days, except when used with temporary, wrap faced, mechanically stabilized earth walls and asphalt overlays.

4.3 Place the cover material on the geotextile in such a manner that the geotextile is not torn, punctured or shifted. Use a minimum 150 mm thick cover layer or twice the maximum aggregate size, whichever is thicker. Do not end-dump cover material directly on geotextiles other than riprap geotextile.

4.4 Limit the construction vehicles in size and mass so that the rutting in the initial layer above the geotextile is not more than 75 mm deep or half the layer thickness, whichever is lesser. Do not turn vehicles on the first layer.

5 INSPECTION

5.1 The owner or owner's representative may randomly inspect geotextile before, during and after (using test pits) installation.

5.2 Any damaged or defective geotextile (that is frayed coating, separated junctions, separated layers, tears, etc.) be repaired/replaced in accordance with **6**.

6 DAMAGE REPAIR

6.1 Repair or replace all torn, punctured or contaminated geotextiles during construction. Repair by placing a patch of the specified geotextile over the affected area. Overlap the existing geotextile with the patch.

6.2 Where geotextile seams are required to be sewn, repair any damaged sheet by sewing unless otherwise indicated on the plans or special provisions, as directed below:

a) *Embankment Geotextile* — Construct embankment stabilization according to details shown on the plans. Place the geotextile layers so that the geotextile machine direction is transverse to the embankment centerline. Spread the geotextile so that all slack and wrinkles are eliminated. Construct embankment in uniform layers.

b) *Riprap Geotextile* — Place geotextile behind and beneath riprap, buttresses, inlays, shear keys and erosion control applications according to the details shown. Demonstrate to the satisfaction of the engineer that the combination of the rock-fill drop height and the thickness of any aggregate cushion, when specified or required, is adequate to prevent puncturing or damaging the geotextile when placing the riprap or stone embankment material, the following limits apply:

Maximum Drop Height, m

Size of Rock (1)	*Onto Geotextile Material* (2)	*Onto an Aggregate Cushion Blanket* (3)
Greater than 90 kg	0	1
90 kg or less	1	1

After placing the riprap, backfill all voids in the riprap face so that the geotextile is completely covered and not visible

c) *Subgrade Geotextile* — For roadbed subgrade separation, prepare the subgrade. Correct geotextile failures, as evidenced by soil pumping or roadbed distortion, by removing any covering material in the affected area and placing a geotextile patch on the exposed geotextile. Cover the patch with the specified cover material and compact before proceeding.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Geosynthetics Sectional Committee, TXD 30

Organization	*Representative(s)*
The South India Textile Research Association Council, Coimbatore	Dr A. N. Desai (***Chairman***)
Ahmedabad Textile Industry's Research Association, Ahmedabad	Shrimati Deepali Plawat Shri Jigar Dave (*Alternate*)
Best Geotechnique Pvt Ltd, Mumbai	Shri Satish Naik
Central Coir Research Institute, Alappuzha	Dr D. Anita Ravindranath Shrimati Sumy Sebastian (*Alternate*)
Central Road Research Institute, New Delhi	Shri Sudhir Mathur Shri Jai Bahagwan (*Alternate*)
Central Soil and Materials Research Station, New Delhi	Dr R. Chitra Shri Manish Gupta (*Alternate*)
Charankattu Coir Mfg Co (P) Ltd, Kerala	Shri C. R. Devraj Shri C. D. Athul Raj (*Alternate*)
Central Water Commission, New Delhi	Representative
Department of Jute and Fibre Technology, Kolkata	Dr Swapan Ghosh Prof (Dr) A. K. Samantha (*Alternate*)
DKTE Centre of Excellence in Nonwovens, Ichalkaranji	Shri Aniket S. Bhute
Ganga Flood Control Commission, Patna	Shri A. K. Sinha Shri Manoj Kumar (*Alternate*)
Garware Wall Ropes Ltd, Pune	Shri Tirumal Kulkarni Shri Rajendra Ghadge (*Alternate*)
Geosynthetics Testing Services Pvt Ltd, Ahmedabad	Dr Deepak Manjunath
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Megaplast India Pvt Ltd, Daman	Shri C. V. Rajesh Shri Hemendra Behera (*Alternate*)
Ministry of Road Transport & Highways, New Delhi	Shri Sanjiv Kumar
Municipal Corporation of Greater Mumbai, Thane	Dr Vishal Ramesh Thombare Shri Mandar Bhalchandra Pingle (*Alternate*)
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